

# FINGER PROSTHETIC MEASUREMENT GUIDE

## Introduction

Hi! You're probably here because you've lost a digit, or are helping someone who has. If the former – sorry about the situation, and hope this can help! If the latter, thanks for being awesome!

I lost my left index in a motorcycle accident in July 2014. Soon after, started on designing this finger which has had many iterations and will continue to improve. It is free and open-source, anyone can use, create, or modify it – just please attribute back to my design, and please do not charge more than cost.

Note to the recipient: Please set reasonable expectations. This, or any prosthetic, will not be a miracle that allows everything you might have done with that digit previously. However, I very much hope you'll get something that is useful, and that you're much happier wearing than not– and, they're getting better all the time! At the end of this doc are more thoughts on wearing mine daily.



## Parameters and getting started

For measurements, you'll need some tape (medical is best, but you could get by with other kinds), scissors, a marker, and a measurement device. Digital calipers are best, but a measuring tape or ruler will do. Be as accurate as possible – all measurements are in millimeters, and decimals are ok too.

### Using the Customizer

Throughout this guide I'll refer to parameters, which are the placeholders for which you'll need to provide measurements. They coincide with the options that you see in the online customizer for Knick's Finger, available from: <http://www.thingiverse.com/thing:1340624>

The configurator is a web page that allows you to set the various parameters, and then generate a custom fitting finger, one part at a time.



### Using OpenSCAD

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Instead of the customizer, you can download the latest “.SCAD” file from the link above, and open it with OpenSCAD, which is free/OSS and cross-platform application: <http://www.openscad.org>

Sometimes this is handy for working around bugs in the configurator, or if you want more control. It shows you all the source code that created this design, and if you're brave you can make your own modifications.

Once you've opened the design, you can directly edit the variable definitions, which will be named the same as the parameters in this guide.



For example, to set `socket_width_bottom` to 28mm, you would change the following line in the file:

```
socket_width_bottom = 20.5;  
to:  
socket_width_bottom = 28;
```

Be careful not to change anything except the number/value in between the equal sign and semicolon.

As with the customizer, each piece is made one at a time. You'll need to set the “part” parameter to the number corresponding to which part to generate. Now save the file, and choose “Render” from the menu, which can take several minutes. When rendered, Choose “Export to STL”.

## Using STL files

It's best to write down all the various measurements on the handy form at the end of this doc, and then plug them in to the customizer. Then pick one part at a time and click “Generate Thing”, which will put the part into a queue. When each part completes it can be downloaded as a “.STL” file.

Once you have STL files from either the customizer or OpenSCAD, anyone well-versed with 3D printers should be able to print them. I've used a very cheap printer from a kit and still had acceptable results, but a more accurate printer will give a better finish and better fitting parts.

Once the parts are printed, check out the assembly video for help putting it together:

<https://www.youtube.com/watch?v=2EEjio4TvL8>

Now, let's take some measurements!

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## Socket Measurement

### Socket Width

This is the single most important measurement for comfort. Too small will never work, but too large can be compensated for by wrapping medical tape on the stump. There are two settings that control this in the model, as seen in the following diagram.



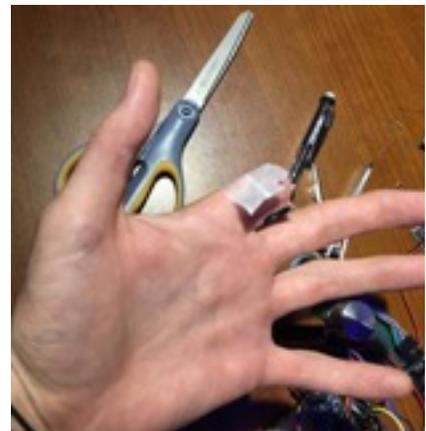
#### **Step 1:**

Wrap the finger remnant / stump with medical tape, not tightly, but just barely snug enough to avoid bunching. Only wrap areas that you expect to be fully covered by the socket.

#### **Step 2:**

Very carefully cut the tape off with scissors, in as straight of a line as possible.

If you have a hard time with this part, try laying a piece of string lengthwise down your finger before taping it, which gives a hold to pull the tape away from the skin.



#### **Step 3:**

Stick the tape smoothly to a flat surface, and measure lengthwise (in millimeters) at the widest point – this gives you the circumference. Now divide this by pi (3.14) in order to get the diameter. In my case:  $62\text{mm} / 3.14 = \underline{19.74\text{mm}}$

The model accepts values for both the bottom and top of the socket, typically the top is a couple mm smaller, which helps for a snug fit.

**Parameters:** socket\_width\_top and socket\_width\_bottom



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## Socket Scallop Depth



Measure from shallowest part of remnant for the socket scallop depth, the cutouts between fingers. Socket depth values for top and bottom should be longer, which increases stability.

*Parameter:* socket\_depth\_scallop

## Socket Depth Top

Measure from the front of the first knuckle, to the tip of the remnant. As long as possible without extending to a point where it rubs or binds.

*Parameter:* socket\_depth\_top



## Socket Depth Bottom

This should be shorter the socket\_depth\_top, to prevent pinching as you make a fist. Close finger as much as possible, and measure from inside to the tip of remnant.

*Parameter:* socket\_depth\_bottom

## Socket Best Practices

You may want to print multiple sockets with different thicknesses, as this can vary depending on healing, and swelling, even throughout a single day. They are the easiest part to snap on and off, so it's super easy to swap them out. I also like to print them with different values for socket\_depth\_top, as I've found that this point takes a fair amount of pressure and can get irritated or calloused. By using a variety, it prevents the strain from always hitting the same spot.

Socket can be trimmed easily if needed, as well as smoothed or sanded with a dremel sanding drum – so if it's too long somewhere – just hack at it a bit, and then measure it once you get it to the right length, for next time.

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## Finger Length

For finger length measurements, it is ideal if there is an intact digit (substitute finger) on the other hand for comparison. If not, you may have to guess more for these values, e.g. most people have similar length index and ring fingers, both of which are slightly shorter than middle finger, or by measuring someone else with similarly sized hands.

### Middle Section Length

#### **Step 1:**

Mark at middle of each knuckle with a marker, while the substitute finger is bent into a fist.



#### **Step 2:**

Straighten the finger, and measure between the lines in mm.

*Parameter:* middle\_section\_length.

### Tip Length

This one is really easy now – use the same mark you already made on the last knuckle, and measure to the tip of the finger.

*Parameter:* tip\_length



### Base Extra Length

The base section (the part that connects to the socket, and sits at the end of the stump), is designed to sit as flush as possible. My amputation was just under my knuckle, so keeping the base short helped so that my knuckles line up well when flexing or making a fist. If your remnant is shorter, you may need to add extra length to the base to keep the knuckles aligned.

*Parameter:* base\_extra\_length

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## Wrist Linkage

Almost done! The wrist linkage length varies depending on how tight of a bracelet you use, and how much slack is in the tendon (fishing line).

To start with, measure the back of hand with your palm flat against a table, wrist bent, and arm sticking up.

Measure from the bend of the wrist, to the middle of the first knuckle in question.

*Parameter:* linkage length



## Other considerations

Write down your measurements in the form on the next page, which will serve as a handy reference for using the configurator or OpenSCAD. Also – take lots of pictures – of every measurement! This helps with any confusion later, and if you’re not making it yourself, the pictures will be a guide for whomever is building it. The parameters are roughly in order of importance – the socket settings are the most important for comfortable fit, where the finger length is just to keep it in proportion with your hands.

There is also a single knuckle mode – for folks missing only the first finger section, or for missing thumbs. In this case there is no middle section, but the other measurements should be about the same.

There are LOTS of other settings (hundreds!). Some I’ve exposed in the configurator as advanced settings, which let you control the clearances between parts – each printer is different, so if parts are sloppy, or too tight to fit, try increasing clearance. If you really get fancy, there are even more settings that can only be seen if you open the source code in OpenSCAD.

If you’re sending your measurements to us or someone else to build it for you, also indicate any color preferences. We’ll do our best, but please be understanding that it is expensive to keep a large inventory, so there may be limited choices. Generally the finger looks best as two-tone, with one color for the plastic structure, and another for the flexible parts.

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## Measurement Worksheet

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Description of loss: \_\_\_\_\_

Color preferences? \_\_\_\_\_

Parameter	Comments	Default (mm)	Measurement (mm)
<u>socket_width_top</u>	Diameter of the top of socket, roughly the diameter/width of the finger remnant nearer the end	18	
<u>socket_width_bottom</u>	Diameter of the bottom of socket, roughly the diameter/width of the finger remnant bottom.	21.5	
<u>socket_depth_scallop</u>	Depth of scalloped part of socket, which provides clearance for finger webbing and movement	21	
<u>socket_depth_top</u>	Depth of socket at the top, typically the deepest part.	35	
<u>socket_depth_bottom</u>	Depth of socket at the bottom, near palm.	27	
<u>middle_section_length</u>	Length of middle section of finger, between second and third mid-knuckle	31	
<u>tip_length</u>	Length of finger tip, from mid-last-knuckle to end.	24.5	
<u>base_extra_length</u>	Extra length for base section, to get the first knuckle aligned.	.5	
<u>linkage_length</u>	Length of the linkage from finger tendon to wrist/bracelet.	62	

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## Finger Prosthetic and Daily Life

I put mine on before I brush my teeth, and take it off when I go to bed. It's generally useful for everyday stuff, and I'm clumsier grasping/holding without it. I can type on my MacBook and plan to make it work with touchscreens in the future.

I can't play guitar with it- just not yet strong or articulate enough. It's also not great at teensy stuff, like assembling more fingers, because you need to rely so much on the sense of touch. Lastly, it's not great for rough heavy work - like moving bricks and lumber, because ultimately its limited by how firmly and tightly it attaches to your stump.

For just about anything short of the above, I find it more useful than not. I'll often go through a day and not think once about it, until I'm wondering why someone is staring, and realize they're interested. It's quite a fun conversation starter- people often ask about what they think is some kind of fancy finger brace, and are surprised to learn it is a prosthetic.

It also helps with self-consciousness and confidence. Without it, the conversations starts like "Oh, sorry – what happened?" With it, it's more often "Wow, what's that cool thing?!".

I find it very comfortable- but getting the settings right for the socket, and using elastic material, makes all the difference. It also protects my very sensitive nerve endings - without it on, a small bump can be very painful.

Occasionally I'll get a little bit sore, especially that first year after the accident, and find that a quick wrap of the really thin medical tape does wonders, or can help to get the right fit. I use a little hand sanitizer every couple days to keep it clean, and weekly or so will clean them with soap and water (or take in the shower!).

Lastly, a shout out to the great folks at <http://enablingthefuture.org> - their work with hand prosthetics gave me inspiration to keep going, and they do great work for lots of people.

I hope this helps you! I love to get pictures/videos of finished creations! Send them, requests for help, suggestions, and any questions to [knick@dangercreations.com](mailto:knick@dangercreations.com)

Best,

--knick

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